

West Lake Landfill  
B# ALDO 79900932  
Bios 34  
Other N/D  
0714

EPA FILE SUMMARY  
WEST LAKE LANDFILL  
NPL SITE  
BRIDGETON, MISSOURI



40052872  
SUPERFUND RECORDS

Received January 23, 1996  
S Kinser

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Letter No 10865W00(1 1) 16

TO U.S. EPA, Region VII  
726 Minnesota Avenue  
Kansas City, Missouri 66101

DATE January 25, 1996

ATTN Mr. Steven Kinser

JOB NO 010865W

PROJECT RI/FS Oversight - West Lake Landfill  
Bridgeton, Missouri

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**REMARKS**

The attached document is the final version of the file summary report for the West Lake Landfill NPL site in Bridgeton, Missouri. Also included is a diskette copy of the document. The document was prepared by team member, LATA, and reviewed by Sverdrup. If you have questions, please contact me at the following telephone number (314)770-4884.

**SVERDRUP ENVIRONMENTAL, INC**



BY Gary M. Neutzling, P.E.

c C M Gross  
Sverdrup Environmental, Inc  
Central File 010865W00(1 1) 16

**EPA FILE SUMMARY**  
**WEST LAKE LANDFILL**  
**NPL SITE**  
**BRIDGETON, MISSOURI**

## EPA FILE SUMMARY - WEST LAKE LANDFILL NPL SITE

### GENERAL BACKGROUND

In early 1966 the Continental Mining and Milling Company Chicago Illinois purchased (from the Atomic Energy Commission) ore residues which were stored at the St Louis Airport The AEC's invitation to bid listed the following residue for purchase 74 000 tons of Belgium Congo pitchblende raffinate containing about 113 tons of uranium 32 500 tons of Colorado raffinate containing about 48 tons of uranium, and 8 700 tons of leached barium sulfate containing about 7 tons of uranium

During 1966 this material was moved from the Airport site to the 9200 Latty Avenue Hazelwood Missouri site Continental Mining and Milling Company possessed License No SMA-862 for this program In January 1967 the Commercial Discount Corporation of Chicago, Illinois, took physical possession of the stockpile License No SMC-907 was issued to Commercial Discount Corporation on December 29 1966, allowing possession of the residues removal of moisture and shipment of the dried residue to the Cotter Corporation facilities in Canon City, Colorado In December 1969, the remaining source material was sold to Cotter Corporation under License No SUB-1022

In August 1970, Cotter Corporation began drying and shipping the remaining residues from the St Louis site to their mill in Canon City, Colorado Approximately 400 dry tons of material per day were processed and shipped in this operation The operation, which was performed for Cotter Corporation by B&K Construction Company, continued until about November 1970 During the August to November period all of the residues were shipped to Canon City with the exception of approximately 10,000 tons of Colorado raffinate and 8 700 tons of leached barium sulfate, containing about 7 tons of uranium oxide ( $U_3O_8$ ) The 8 700 tons of leached barium sulfate were mixed with about 39,000 tons of soil at the Latty Avenue site

In April, 1974 Region III representatives of NRC's Office of Inspection and Enforcement visited the Cotter Corporation's Latty Avenue site to check on the progress of the decommissioning activities being performed there This inspection disclosed that in 1973 Cotter Corporation had disposed of approximately 8,700 tons of leached barium sulfate residues mixed with 39,000 tons of soil at a local landfill

By letter dated June 2, 1976, the Missouri Department of Natural Resources (MDNR) forwarded to the NRC's Region III office newspaper articles which alleged that only 9,000 tons of waste had been moved from the Latty Avenue site rather than 40 000 tons and that

it was moved to the West Lake Landfill in Bridgeton and that the waste was covered with only about 3 feet of soil

The West Lake Landfill had been used since 1962 for the disposal of municipal refuse, industrial solid and liquid wastes, and construction demolition debris. Between 1939 and the spring of 1987, limestone was quarried there. Landfill operations filled in some of the excavated pits from the quarry operations. Also on the property is an active industrial complex in which concrete ingredients are measured and combined before mixing ("batching"), and asphalt aggregate is prepared.

The unregulated landfill in which the radioactive material was placed in 1973 was closed in 1974 by the Missouri Department of Natural Resources (MDNR). Also in 1974, under an MDNR permit, a newer sanitary landfill was opened and now operates in an adjacent area on the West Lake Landfill property. The newer landfill is protected from groundwater contact and a leachate collection system has been installed. Leachate is pumped to a treatment system consisting of a lime precipitation unit followed in series by an aerated lagoon and two unaerated lagoons. The final lagoon effluent is discharged into St. Louis Metropolitan Sewer District sewers.

Numerous investigations have been conducted to delineate the areas and media impacted by the disposition of the residue-soil mixture at the West Lake Landfill. These investigations include reviews of pertinent records, interviews of individuals, and independent sampling, measurements and chemical analyses. The file documents summarizing these investigations are described in the remainder of this document.

## **SUMMARIES OF FILED DOCUMENTS**

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**EPA-0055**

**Office Of Inspection And Enforcement Investigation Report No 76-01  
United States Nuclear Regulatory Commission, August 1976**

*Keywords radiological characterization, site history cover*

The earliest reports of the waste disposal action appeared in the Post-Dispatch, a St. Louis newspaper. These reports led to an NRC investigation consisting of interviews and visits to the Latty Ave. and West Lake Landfill sites. Environmental samples were taken and beta-gamma surveys were made at the Latty Avenue and West Lake Landfill sites on August 11, 1976. The Latty Avenue site and environs was revisited on October 20, 1976.

for additional environmental samples and alpha, beta-gamma direct surveys. The Latty Avenue environmental samples confirmed the removal of the bulk of materials but showed that some residual contamination remained. The Latty Avenue surveys showed radiation levels exceeding NRC criteria for decontamination of land areas prior to return to unrestricted use. The West Lake Landfill surveys indicated that radioactive material was buried there.

Based on the information collected, NRC investigators concluded that

- About 8 700 tons of leached barium sulfate residues had been mixed with about 39 000 tons of soil at Latty Avenue.
- During the period July 16 to October 9, 1973, over 43,000 tons of waste and soil were removed from the Latty Avenue site.
- The 43,000 tons of waste and soil were dumped at the West Lake Landfill.
- The material dumped at West Lake Landfill was covered by about 3 feet of other [non-contaminated] soil.

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#### **NRC 0158**

#### **Report On Site Visit - West Lake Landfill, St. Louis County, Missouri Radiation Management Corp., 1981**

*Keywords: water analysis, soil analysis, external dose*

A fly-over radiological survey (ARMS flight) performed in 1978 showed external radiation levels as high as 100  $\mu$ R/hr in the area indicated by the site supervisor as that where Latty Avenue materials were disposed. This survey revealed another possible contaminated area in a fill area previously believed to be 'clean'. In September and November of 1980, Radiation Management Corporation (RMC) visited the West Lake Landfill in St. Louis County, Missouri, and performed a detailed radiological survey of the West Lake Landfill under contract to the NRC.

This survey was necessary to determine the extent of radiological contamination. The purpose of these visits was to (1) define the radiological conditions of the West Lake Landfill site, (2) obtain sufficient data to allow RMC to prepare a detailed site radiological survey plan, and (3) perform an engineering evaluation to determine whether remedial actions should and can be taken. Prior to this survey, little was known about the location or activity of radio nuclide bearing soils in the landfill. The RMC survey included

- measurement of external dose rates,
- grab-sample air evaluations, and
- water and surface soil analyses

As a result of the visits, RMC was able to define two extensive areas of contamination. Based in preliminary measurements RMC concluded that radiation exposure risk to site workers were minimal. Elevated concentrations of uranium and daughters existed in landfill soils but no unusual levels were detected in off-site field soils. RMC did not find any indications that groundwater movement of materials from the site had occurred. Results of the preliminary site visits were used to develop site survey plans for additional investigations.

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**EPA-0057 - NUREG/CR 2722**

**Radiological Survey Of The West Lake Landfill, St Louis County, Missouri**

**Radiation Management Corporation**

**under contract to Division of Fuel Cycle and Material Safety**

**Office of the Nuclear Material Safety and Safeguards, U S Nuclear Regulatory Commission, May 1982**

*Keywords radiological characterization, chemical analysis radon vegetation subsurface soil radium thorium protactinium risk assessment cover*

The results of a radiological survey of the West Lake Landfill performed by Radiation Management Corp (RMC) during the spring and summer of 1981 was presented in this report. The purpose of this survey was to define the radiological conditions of the West Lake Landfill site to an extent sufficient to allow an engineering evaluation for determination whether remedial actions should and could be undertaken.

Surface gamma surveys, surface beta-gamma surveys, and direct measurement of soils, groundwater, vegetation, and air were performed on-site using two mobile facilities designed by RMC. A small number of samples were returned to the RMC radiological laboratories in Philadelphia for (1) radiological analyses which could not be performed in the field, and (2) quality assurance checks on the field measurements. In addition, a series of nonradiological measurements were performed to identify the possible presence of toxic or hazardous chemicals.

The measurements used to evaluate the site included the following

- external gamma exposure rate 1 meter above the ground surface and beta-gamma count rates 1 cm above the ground surface,
- radionuclide concentrations in surface soils,
- radionuclide concentrations in subsurface deposits,
- gross activity and radionuclide concentrations in surface and subsurface water samples,
- radon flux emanating from surfaces
- airborne radioactivity
- gross activity in vegetation and
- measurement of radon gas emanation and accumulation in a building on-site

The survey results were interpreted to indicate that the West Lake Landfill contained two areas of surface and/or subsurface contamination. External radiation levels are detectable in both areas. The highest reading detected in the most recent survey was 1.6 mR/hr in Area 2, near a utility building that was denoted as the "Shuman Building".

Analyses of soil samples from both areas, as well as in-situ measurements, showed that the contaminants present at West Lake consist of uranium and uranium daughters. Chemical analyses revealed that high concentrations of barium and sulfates were present in the radioactive material. These results were interpreted to confirm reports that the radioactive material was composed of uranium and uranium ore, which were contained in leached barium sulfate residues transferred from the Latty Avenue site in Hazelwood, Missouri.

Analysis of soils also showed an elevated ratio of thorium-230 ( $\text{Th}^{230}$ ) to radium-226 ( $\text{Ra}^{226}$ ). Also, the concentrations of protactinium-231 ( $\text{Pa}^{231}$ ), inferred from radium-223 ( $\text{Ra}^{223}$ ) determinations, were shown to be high. It was inferred that the relatively high concentration of thorium resulted from separation of both uranium and radium from the uranium ores, thus "depleting" the ores of uranium and radium, or "enriching" the residues in thorium. The postulated "enrichment" model was supported by the observed presence of  $\text{Pa}^{231}$  which would be expected to remain in the soil.

The RMC survey results indicated that radioactivity is due to members of the naturally-occurring uranium-238 ( $\text{U}^{238}$ ) and uranium-235 ( $\text{U}^{235}$ ) series. Left in an undisturbed state,



radionuclides would be expected to establish secular equilibrium. For a sample of material in secular equilibrium, the activity of each radio nuclide in a given decay series will equal the activity of every other radio nuclide in that series. Because  $Ra^{226}$  was depleted with respect to  $Th^{230}$ ,  $Ra^{226}$  activity will increase over time to a level in excess of those observed at the time of the analysis. As a result,  $Ra^{226}$  activity will increase ninefold over the present level over the next 200 years which must be taken into consideration when developing remedial action plans.

Auger hole measurements were collected using sodium-iodide detectors and intrinsic-germanium detector coupled to a multi-channel analyzer. The measurement data showed that nearly all the contamination present was located below the landfill surface. Additional locations near the northwest berm in Area 2 exhibited anomalous radiation and were identified as suspect area where radioactive contamination might be present at the surface or near-surface. The radioactive zones ranged from 2 to 15 feet in thickness, and appeared to form a contiguous layer covering an area of about 14 acres (68 000 sq yd) in Area 2 and about 2 acres (10,000 sq yd) in Area 1. RMC estimated that 150 000 cu yd of radioactive material may have been buried within the two areas. This quantity would correspond to roughly 170,000 tons of soil.

It was noted by RMC that some on-site samples have exhibited gross beta activity above EPA drinking water guidelines (attributable to krypton-40), but that radioactivity in off-site water samples was not observed to exceed applicable guidelines. The absence of significant contamination in the leachate liquid or sludge was cited to suggest that the buried ore residues were (1) probably not soluble, (2) not moving through the landfill, and (3) not moving off-site via groundwater.

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**EPA-0036**

**Report Of Water Sample Analyses**

**from Scott Meierotto to Mr William Canney, c/o West Lake Quarry, Hazelwood MO 63044, 1982**

*Keywords groundwater analysis*

This report is a custody and transmittal document for the analyses of groundwater samples from 8 of the 9 monitoring wells at the West Lake Landfill property. The water samples were collected on December 10, 1981. The analyses reported included (1) principal cations/anions, (2) metals, and (3) water quality parameters (e.g. turbidity, alkalinity, COD etc.). No radio nuclide analyses were performed.

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**NRC-0012**

**Survey For Berm Erosion West Lake Landfill, St Louis County, Missouri  
Oak Ridge Associated Universities, April 1984**

*Keywords radiological characterization berm, Ford property soil analysis radium thorium protactinium cover*

In March 1984, representatives from Oak Ridge Associated Universities (ORAU) performed a radiological survey along a section of the berm bounding the West Lake Landfill to determine if erosion of the berm was leading to contamination of the adjacent property (designated as the Ford Property ). Information collected included exposure rates, radionuclide concentrations in surface soil, and the location of elevated contact radiation levels relative to the surface topography

An initial scan performed with sodium iodide (NaI) scintillation detectors indicated that elevated readings were present along the berm in the far west portion of the landfill. This area was selected for further study and no further measurements or sampling were undertaken in other portions of the landfill. Radionuclides determined to be present included  $\text{Ra}^{226}$ ,  $\text{Th}^{230}$ ,  $\text{Pa}^{231}$ , and actinium-227 ( $\text{Ac}^{227}$ ). The maximum concentrations of  $\text{Ra}^{226}$  were 699 pCi/g and 662 pCi/g. Ratios of  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  ranged from 25.1 to 40.1.

The study concluded that (1) erosion was occurring, (2) concentrations of  $\text{Ra}^{226}$  and  $\text{Th}^{230}$  were elevated at the base of the berm, and (3) radiological contamination appears to extend onto the adjacent property. ORAU also determined that 1.0-1.5 meters of additional fill had been applied to a portion of the landfill near the office building (designated as the Shuman Building ). The study estimates that the additional fill reduced direct radiation levels at some locations by a factor of 2.

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**NRC-0204**

**Engineering Evaluation of Options for Disposition of Radioactively Contaminated Residues Presently in the West Lake Landfill, St Louis, Missouri  
University of Missouri, Columbia, December 1984**

*Keywords risk assessment berm radium thorium, radon engineering assessment remedial action cost*

[NOTE] The date of this study is uncertain. Three copies of the University of Missouri report are in the document record. The review copy is described as a draft and dated November 1984, but the pages of the report have a printout date of July 17, 1989. A second copy was transmitted to Oak Ridge Associated Universities (ORAU) in December 1984 but the attached report also has a printout date of July 17, 1989. Handwritten notations on a third version edited by the NRC indicate that the final review was completed after July 1989. Others have observed this inconsistency and suggest that ORAU retyped the report on July

17 1989 as a final version but never changed the date of original authorship The file copy is incomplete and lacks several tables and appendices ]

In March 1983, ORAU acting as an agent for NRC, contracted with the University of Missouri - Columbia Department of Civil Engineering (UMC) to conduct an environmental impact assessment and engineering evaluation of possible remedial measures at the West Lake Landfill Only the radiological aspect of the landfill was to be considered in the study

Most of the information presented in the report was obtained from existing reports and memoranda, with only limited collection of on-site data by UMC personnel in 1983 and ORAU personnel in March 1984 These data confirmed the previous measurements by Radiation Management Corporation (RMC) with the exception that higher levels of surface contamination were discovered in March 1984 on the slope of the berm This data was interpreted as evidence that surface erosion is responsible for uncovering buried radioactive material as was hypothesized in the earlier RMC report

Present and future doses were calculated using DOE procedures for a hypothetical Maximally Exposed Individual (MEI) The dose to a MEI approximates the maximum possible dose anyone could receive from radioactive debris in the West Lake Landfill The calculated doses are above guidelines for exposure to individual members of the population

Assumptions used in the dose calculations include the following

- Using the RMC data and averaging the auger hole measurements over the two volumes of radioactive material found in Areas 1 and 2 a mean concentration of 90 pCi/g was calculated for  $\text{Ra}^{226}$
- Next, the ratios of  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  must be established since the level of  $\text{Th}^{230}$  will determine the increase of  $\text{Ra}^{226}$  with time The ratio of  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  ranged from 5:1 to 150:1, with most of the data in the 30:1 to 50:1 range
- The total mass of radioactive material in the landfill was stated in the RMC report as  $6.6 \times 10^{11}$  grams UMC verified this estimate by visually integrating the volume of radioactive material from the graphs in the RMC report and multiplying by an average soil density, resulting in  $1.5 \times 10^{11}$  grams UMC determined that the total activity of radiological materials could range between 1,600 Ci and 7,000 Ci
- Knowing the total  $\text{Ra}^{226}$  activity in the site, UMC estimated that the release of radon-222 ( $\text{Rn}^{222}$ ) gas from the surface of the landfill was 25 Ci/sec

- UMC noted that the radon gas flux level will not be constant over time due to the depletion of  $\text{Ra}^{226}$  relative to  $\text{Th}^{230}$ . The  $\text{Ra}^{226}$  activity (and thus the  $\text{Rn}^{222}$  gas flux) will increase by a factor of five over the next 100 years, by a factor of nine 200 years from now and by a factor of thirty-five 1,000 years from now. All radionuclides in the decay chain below  $\text{Ra}^{226}$  will also be increased by this amount.

Based upon this characterization of the material present and using established guidelines, some type of remedial action is needed to protect the public from unrestricted use of the site. Although many radionuclides in the radioactive material are at or near threshold for remedial action,  $\text{Th}^{230}$  and  $\text{Ra}^{226}$  levels are greater than specified by these guidelines. This also creates the situation where the  $\text{Ra}^{226}$  activity will increase with time, requiring action to preclude possible increased exposure in the future. Calculations do indicate, however, that simple remedial action at the site will result in negligible exposure to the general public and only moderate exposure of the worst exposed individual who would routinely work at the site.

The following remedial action options were evaluated in this study for feasibility of implementation, reduction in radiation exposures, environmental impacts, and cost:

Option A - No remedial action

Option B - Stabilization on-site with restricted land use

Option C - Extending the landfill off site

Option D - Removing radioactive soil and relocating it at Barnwell, S C

Option E - Extensive stabilization on-site with land-use restrictions

Option F - Extensive stabilization on-site with land-use restrictions and construction of slurry walls to control groundwater motion

Option B, stabilization on-site with land-use restriction, was chosen as the best alternative. This alternative (B) would involve covering the contaminated soil with five feet of clean fill excavated from loess deposits near the landfill. This soil layer would reduce surface exposure, radon gas emanation, and infiltration water available to leach radioactive and nonradioactive wastes from within the landfill. The berm along the northwest side of the landfill would be rebuilt to halt the erosion of radioactive soil. After this stabilization has been completed, the surface of the contaminated areas will be available for placement of another layer of demolition fill. The alternative options (C, D, E, and F) were not recommended because of relatively high costs and/or inappropriate use of space in a licensed waste disposal.

Land-use restrictions would be necessary to ensure that the site, after closure, is put to some use such that excavation on-site will be unlikely and future construction on the site is discouraged. Establishment of an appropriate land-use pattern at the time of closure, rather than temporarily fencing off the area from all use, was judged to be the most effective method for preventing inappropriate activity on the site far into the future. A park, golf course, or parking lot(s) would all be examples of acceptable future uses for the site. Costs of stabilization work for Option B were estimated to be \$367,000.

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**Hydrogeologic Investigation West Lake Landfill, Primary Phase Report  
Burns & McDonnell, Kansas City Missouri, October 1986**

*Keywords groundwater flow groundwater quality*

This document is the first comprehensive study of the hydrogeology of the vadose zone and unconsolidated alluvium at the site. The study does not address bedrock hydrodynamics nor water quality. The results of sampling and analyses of the groundwater from pre-existing and newly installed monitoring wells are presented. A total of 18 wells were sampled during two sampling rounds: 1) the winter of 1985 and 2) the summer of 1986. Chemical analyses included major chemistry and hazardous constituents (EPA Methods 624 and 625). Radiochemical analyses were not performed but gross alpha and gross beta determinations were reported.

The lithology and stratigraphy of the unconsolidated sediments were not fully described in this report. Moreover, the vertical and horizontal extent of contamination were not adequately addressed. The report concluded that there was only minor evidence of leaching of radioactive contaminants from the wastes to the groundwater. The presence of other pollutants in the groundwater was reported to be of minor significance.

The authors note the presence of a groundwater mound located on the southern part of the site. They ascribe the mounding effect to (1) water being pumped from the quarry and discharged at the ground surface up-gradient of the mound, (2) surface infiltration from the drainage ditches along Old St. Charles Rock Road, and (3) possible leakage from surface water holding ponds immediately west of the existing quarry. Groundwater gradients are described as extremely low. The authors estimate that groundwater flow rates in the upper and lower zones of the unconsolidated aquifer are 500 gpd and 400,000 gpd, respectively. Principal findings from this report are included below.

- The alluvium of the Missouri River forms the major aquifer in the vicinity of the site. The underlying bedrock which forms the valley floor is buried beneath the alluvium.

- Alluvial deposits of the Missouri River are in hydraulic communication with the river, thus the river has a major influence on water levels in the alluvium. Although the rise and fall of the aquifer is less than that of the correlative change in river stage, the change in groundwater elevation is relatively uniform throughout the entire extent of the aquifer in the site vicinity.
- The predominant direction of groundwater flow in the aquifer in the region near the site is northwestward toward the Missouri River. There are broad fluctuations in this flow direction throughout the year and the predominant flow direction ranges from slightly south of due west to northwest. During short periods of the year (primarily in the spring and for short periods in winter), when the river stage is rising rapidly, the predominant groundwater flow direction in the aquifer may be temporarily reversed in the localized vicinity of the river.
- Other localized effects of only minor significance, may affect groundwater flow directions in the aquifer. The only local feature of note is a perennial groundwater mound.
- Throughout most of its extent, the aquifer is generally unconfined. Relatively low-permeability discontinuous clayey and silty zones within the alluvium may cause semiconfined and perched water conditions in localized areas.
- Gradients in hydraulic head in the lower aquifer are, at times, extremely low. Thus, minor fluctuations in head (in the range of 1/10-foot in any one well) may be sufficient to cause changes in flow direction. But because the gradients are very low at such times, groundwater flow rates are negligible.
- At times, there may be two to three feet of differential in hydraulic head across the site. The pattern in hydraulic head distribution in the deep aquifer at such times is seen to reflect approximately the same pattern as the head distribution in the shallow aquifer. Thus, the surface water features which recharge the shallow part of the aquifer and cause groundwater recharge in the southeastern part of the site also recharge the deeper part of the aquifer by vertical infiltration from above. During such times, groundwater flow in the deep portion of the aquifer is predominantly towards the west and northwest. During all times of measurement the hydraulic gradients in the deeper part of the aquifer were substantially less than that in the shallow part of the aquifer.
- The groundwater flow rates in the upper and lower zones of the aquifer are estimated to be 500 gallons per day and 400,000 gallons per day, respectively.

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**Hydrogeological Investigation of the West Lake Landfill**  
**Dames & Moore , October 1986**

(NOTE report mentioned in EPA-TES reports but no copies exist in the file record)

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**NUREG-1308 / NRC-0222**

**Radioactive Material in the West Lake Landfill Summary Report Rev 1**  
**DIVISION of Industrial and Medical Nuclear Safety, Office of Nuclear Material Safety**  
**and Safeguards**  
**U S Nuclear Regulatory Commission, 1988**

*Keywords site history radiological characterization risk assessment remedial action*

The circumstances which led to the disposal of radioactive materials at the West Lake Landfill is described in this Nuclear Regulatory Agency (NRC) summary report. Also described, are the major environmental aspects of the site as they relate to potential disposition of the materials (e g , areal extent of contaminated ground, geology hydrology, demographics, etc ). Other sections of the report are devoted to a review of the surveys and analyses that have been conducted and to estimations of the radioactive inventory still present at the site.

The conclusions of the report explain that measures must be taken to establish adequate permanent control of the radioactive waste and to mitigate the potential long-term adverse impacts from its existing temporary storage conditions. Furthermore the information collected to date was found to be inadequate for a technological determination of several important issues, i e , whether mixed wastes are involved, whether on-site disposal is practical technologically, and what alternative methods might be acceptable if on-site disposal is found to be impractical.

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**Site Characterization and Remedial Action Concepts for the West Lake Landfill  
Office of Nuclear Material Safety and Safeguards, Nuclear Regulatory Agency, July 1989**

*Keywords site history radiological characterization risk assessment remedial action*

This report is based on NRC-0204 Engineering Evaluation of Options for Disposition of Radioactively Contaminated Residues Presently in the West Lake Landfill St Louis Missouri , and NUREG-1308 / NRC-0222 Radioactive Material in the West Lake Landfill, Summary Report Most of the information dates from 1983-1984 when the University of Missouri first compiled their findings However, additional data such as more recent water sampling results, were added Also described are existing site conditions including minor changes in details of topography and roads etc caused by continued use of the site as a sanitary landfill

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**Evaluation of the West Lake Landfill Site Hazardous Ranking System (HRS) Scoring Package  
Foth & Van Dyke, December, 1989**

*Keywords site history risk assessment*

The results of Foth & Van Dyke's investigation regarding the hazardous ranking system (HRS) scoring package and background (support) information for the West Lake Landfill are documented in this letter In addition, an evaluation was made based upon currently available information for the site to ascertain if pollutant or contaminant releases may present imminent and substantial danger to public health and welfare

An evaluation of the impact of the site on the public health and welfare was performed by a Foth & Van Dyke toxicologist An insufficient amount of data was determined to be available to conduct a formal risk assessment Recommendations contained in the report include the following actions

- measure radioactivity of groundwater used at off-site locations,
- determine groundwater usage patterns for the immediate vicinity,
- conduct air sampling and modeling, to determine if this exposure pathway presents a health risk to persons off-site, e g , Spanish Lake Village, Ralston-Purina employees, etc ,



- determine if the radon flux will increase with time as the radioactive decay produces higher levels of radon
- assuming migration of a contaminated groundwater plume to the Missouri River determine a future radon flux in the area west of the landfill since dwellings in this area may be subject to radon gas contamination,
- conduct an investigation to determine if radon gas is a problem (health hazard) in buildings adjacent to the landfill,
- determine off-site soil contamination e g , farmers fields, neighborhoods, etc , and
- collect area surface water and sediment samples for radiological analyses

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**Dames & Moore, Phase II Investigation Report, Ford Property  
U S Real Estate Division, Ford Financial Services, Earth City, Missouri, 1990**

*Keywords Ford property radiological characterization soil analysis groundwater analysis chemical analysis radiochemical analysis soil analysis*

In April, 1990 the Ford Financial Services Group, authorized Dames & Moore (D&M) to proceed with a Phase II Site Investigation to further document conditions at the property adjacent to the West Lake Landfill pursuant to a real estate transaction. The investigation was confined to areas along the western and northwestern perimeter of the landfill and excluded the area around the two "hot spots" located during an earlier Phase I investigation in the interior of the landfill.

The investigation included a walkover gamma survey (designated as "overland survey ") at and above the ground surface within two grids. The gamma survey included areas to the north and west of the landfill. A surface soil survey, using a direct reading meter, was conducted to characterize shallow (less than 12 inch depth) soils from property locations adjacent to the landfill where contamination was suspected based on the Phase I results. Four sediment/soil samples were collected from four locations where chemical or radiological contamination might be expected to have migrated from the landfill via surface water. A list of activities conducted during the Phase II investigation included

- surface radiological surveys,
- subsurface radiological and chemical surveys,

- surface sediment/soil sampling
- monitoring well installation
- groundwater sampling, and
- chemical and radiological laboratory analyses

The only noteworthy item in the report concerned the discussion of findings of groundwater analyses. Groundwater samples were analyzed both as taken and after filtration with a 45-micron filter. For samples from four wells, the filtered samples were reported as showing radioactivity below the U.S. EPA drinking water standard of 15 pCi/l for gross alpha, 50 pCi/l for gross beta, and 5 pCi/l for  $\text{Ra}^{226}$  plus  $\text{Ra}^{228}$ . For samples of unfiltered water from the same wells, the gross alpha values were elevated to 17.2 to 202 pCi/l. These elevated values were considered "qualified" by the authors because the sum of the individual nuclides analyzed did not show a corresponding total of alpha activity. The general findings of this Phase II report were that there was no substantial evidence that radioactive material in the West Lake Landfill has migrated to the northwest and west and onto the Ford property. This conclusion was generally well supported by the data reported. Specific findings for each of the activities conducted are summarized in the following subsections.

## SURFACE RADIOLOGICAL SURVEYS

Gamma radiation surveys were conducted on surface soils in areas north and west of the West Lake Landfill. These areas were investigated because they receive a large amount of surface run-off from the landfill. The surface soil survey was conducted using a direct-reading meter. The surveys indicated that there was no significant surface radiological contamination present.

## SUBSURFACE RADIOLOGICAL AND CHEMICAL SURVEYS

Subsurface soil conditions were surveyed radiologically from the surface to groundwater in several locations to the north and west of the landfill. Gamma radiation was measured in soil borings using a Geiger-Mueller (GM) survey meter. A photoionization detector was used to detect organic chemicals. Neither radiological nor chemical contamination was reportedly indicated by the observed instrument readings.

## SURFACE SEDIMENT/SOIL SAMPLING

A total of twenty-six surface soil samples were collected from 0 to 12 inches in depth below the ground surface from property locations adjacent to the landfill and submitted for

chemical and radiological analysis as either a whole sample or as a composite. Soil samples were collected from (1) locations where contamination was suspected from the Phase I effort, (2) locations where dredge soils from the ditch along Old St. Charles Rock Road and (3) from unbiased locations along the perimeter of the landfill. Biased sediment/soil sample locations were established where topographic features would favor chemical or radiological contaminant migration from the landfill via surface water.

## MONITORING WELL INSTALLATION & GROUNDWATER SAMPLING

Groundwater was sampled from newly installed monitoring wells constructed in the same soil borings that were mentioned previously.

## CHEMICAL AND RADIOLOGICAL LABORATORY ANALYSES

Of all the soil samples collected from adjacent properties, radiological contamination was detected only in the samples collected from the two locations where radiological contamination had been indicated in the Phase I investigation. Other conclusions related to the presence of nonradiological contamination are compiled below.

- Very low levels (parts per billion) of organic contamination were reported for two soil sample composites prepared from sediment/soil collected on adjacent property locations. The reported values were below the analytical limit of detection and were not considered significant.
- Low level (part per billion) concentrations of some organic chemicals were detected in several of the groundwater samples. Several of these, however, were believed to be attributable to background contamination from the laboratory and D&M scientists did not believe the concentrations observed represented a significant environmental concern.
- Two semi-volatile BNAs [chrysene and bis(2-Ethylhexyl)-phthalate] were detected in very low levels (1 to 27 ppb) in four (4) of the groundwater samples.
- Other chemical contaminants tested for in the groundwater (i.e., metals, cyanide) were not present in sufficient concentration to represent a significant environmental concern.
- Gross alpha was the only radiological parameter that appeared to be somewhat elevated in some of the groundwater samples. The sum of the individual components that typically comprise this parameter failed to confirm the gross alpha totals.

Based on these results, the authors of the Phase II report compiled the following conclusions

- Only the samples collected from the two locations where radiological contamination had been indicated from the Phase I investigation exhibited radiological contamination in laboratory analyses and gamma radiation survey
- Radiological contamination present within the landfill did not appear to have influenced the surface gamma radiation readings over the 23 acres surveyed
- There did not appear to be significant groundwater contamination
- The results provided from this investigation were interpreted as evidence that the radioactive material resident in the West Lake Landfill has not migrated to Earth City (Ford) property

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**Dames & Moore, Phase III Radiological Site Assessment - Earth City Industrial Park**  
**Prepared for U S Real Estate Division, Ford Financial Services, Earth City Missouri**  
**June 1991**

*Keywords Ford property radiological characterization soil analysis groundwater analysis radium thorium uranium remedial action cost*

In April, 1991 a Phase III radiological investigation was conducted by Dames and Moore (D&M) at the Earth City property. The investigation was conducted as a follow-up to the Phase II investigation for the purpose of further characterizing the extent of radiological contamination that was detected in two localized areas during the Phase II investigation. The investigation involved an overland gamma survey, a downhole gamma survey, soil sampling and analysis, and groundwater sampling and analysis.

This Radiological Site Assessment reported that the area and depth of contamination have been established on the two small contaminated areas on adjacent property, which were mentioned in the Phase II report discussed above. The following information regarding these two areas were documented in this report:

- The "northern biased" (D&M designation) location encompasses an area of approximately 4,300 square feet and the depth of contamination was approximately one foot. The predominant nuclides that are present above background levels in this area are  $\text{Ra}^{226}$  and  $\text{U}^{238}$ .  $\text{Ra}^{226}$  was detected in a range of 2.9 to 690 pCi/g and  $\text{U}^{238}$  was detected at one location at a concentration of 5.9 pCi/g.

- The southern biased (D&M designation) location is in a localized area adjacent to the West Lake property fence line.  $\text{Ra}^{226}$  was detected at a range of activities from 2.3 to 43 pCi/g and  $\text{U}^{238}$  was detected at concentrations from 6.7 to 9.2 pCi/g. The contaminated area was determined to be approximately 90 square feet and the depth was approximately 3 to 3.5 feet. Analysis of the groundwater samples indicated no evidence of elevated activities of target nuclides  $\text{Ra}^{226}$ ,  $\text{Th}^{230}$ , and  $\text{U}^{238}$  which are characteristic of radioactive material found in the West Lake Landfill.

Remediation costs were estimated at \$200,000 for excavation, transportation, and disposal of approximately 4,600 cubic feet of contaminated soil. The report recommended additional actions to minimize contamination spread onto the property from the adjacent West Lake Landfill.

The D&M soil sample data consistently shows that the ratios of  $\text{Ra}^{226}$  to  $\text{U}^{238}$  and  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  are enriched. The report notes the strong correlation between the Ford property sample data and the soil sample data presented in the NUREG-1308 report from the St. Louis Airport Site. As a result, it was concluded that the radiological contamination on the Ford property could only have come from materials placed in the West Lake Landfill which were ultimately generated at the St. Louis Airport Site.

D&M does not discuss the inconsistency between  $\text{U}^{238}$  results from two different analysis methods applied to the same groundwater samples. A single paragraph in the Executive Summary states that the analytical results "confirm that no migration of radioactive material into the shallow groundwater has occurred under the Ford property." It goes on to state flatly that the analysis indicated no evidence of elevated  $\text{U}^{238}$ , then recommends an annual analysis program that conspicuously omits the "gamma scan" analysis.

An apparent contradiction in contaminant distribution exists between the Oak Ridge Associated Universities (ORAU) 1984 survey of the north face of the landfill and the Phase III report prepared by D&M. The gamma survey data contained in the Phase III report does not indicate a contaminated area along the boundary at this latitude. The evidence presented does not preclude the possibility that  $\text{Th}^{230}$  contamination may have been spread onto the Ford property field in locations where the gamma readings are below 10 microR/hr.

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## EPA-TES Trip Report

West Lake Landfill Bridgeton, Missouri, Remedial Investigation/Feasibility Study

U S EPA Region VI, Technical Enforcement Support

Performed By Metcalf & Eddy, Inc , November 1991

*Keywords Ford property berm*

The TES X Contractor Metcalf & Eddy (M&E), was requested by the U S EPA Region VII to conduct a site visit at West Lake Landfill (West Lake) in Bridgeton, Missouri. West Lake is currently owned and operated by Laidlaw Waste Systems Inc (Laidlaw). The site visit was conducted so that M&E personnel could become familiar with the site physiography, topography, geology, hydrology and current conditions at West Lake. In addition, M&E visited the Earth City Industrial Park (Ford) property (adjacent to the northern boundary of the landfill) to locate and observe the characteristics of the two areas impacted by radiological contamination.

- The TES personnel submitted several findings and recommendations for additional work at West Lake Landfill. These observations are summarized below.
- Historic bedrock quarry activities should be evaluated to gain additional information that will help to evaluate bedrock characteristics, groundwater characteristics and the possible locations of past waste disposal activities.
- The heterogeneous topography of the old portion of the landfill may be the result of uncontrolled waste disposal activities. Aerial photographs also suggest non-systematic shifting of waste disposal areas. The radiological data should be scrutinized to evaluate whether an accurate depiction of the vertical extent of contamination has been made.
- The hydraulic properties of bedrock must be further investigated to characterize hydraulic gradients in the bedrock formation.
- The thickness and elevation of the radiologically contaminated fill material in relation to the elevation of the flood plain (Earth City Industrial Park property) and lack of identified groundwater contamination suggests that through flow probably is not the cause of the contamination at Earth City.
- Berm areas were reworked by Laidlaw bulldozer operators prior to the site visit. A Laidlaw representative stated that these areas were cleared to allow mobilization of utility trucks and drill rigs.

- The location and limited areal extent of contamination on the Earth City Industrial Park property suggest that mass movement of entrained contaminants in berm material and surface water flow are the dominant contaminant migration pathway. It is suggested that berm material be evaluated to determine composition and hydraulic characteristics of the berm.

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## **West Lake Landfill Berm Assessment**

### **Metcalf & Eddy, 1992**

*Keywords: berm, Ford property, remedial actions*

Metcalf & Eddy (M&E) identified the minimum data requirements necessary to perform a preliminary evaluation of the berm at the north end of the West Lake Landfill site and prepared a scope of work for an interim measures study to separate the berm and the adjacent Earth City (Ford) property. Based on the evaluation of previous investigation survey results, M&E identified the following tasks for future implementation:

- Evaluate potential interim measure action alternatives to include surface water diversion and collection systems, and subsurface barriers alternative evaluation.
- Design and install a physical barrier between the West Lake Landfill and the Earth City property to prevent transport (by mass movement or surface water) of radiologically contaminated soils on to the Earth City property.
- Install a representative number of soil borings in the berm to characterize berm soils and further identify areas of contamination. Soil samples should be analyzed for radioactivity, selected radionuclides, and priority pollutants. Non-vertical (angled) borings using lightweight or portable drilling equipment may be necessary to perform this task.
- Groundwater or leachate encountered during boring advancement should be sampled and analyzed for radionuclides and for volatile and semivolatile organic compounds, total petroleum hydrocarbons, pesticides, PCBs, metals, and cyanides.
- The hydraulic, geotechnical, and chemical properties of berm soils must be determined to ascertain if this structure acts to contain contaminants. The description of physical properties of the soils must detail the following: soil type including grain size analysis, specific gravity, moisture content, Atterberg limits, permeability, and biological activity. The description of the soil chemistry should include solubility, ion speciation, adsorption coefficients, leachability, mineral

partition coefficients, and chemical and sorptive properties. In addition, the soils should be analyzed for radioactivity, selected radionuclides, and priority pollutants to further define the extent of contamination.

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**Major Modification Submittal - Bridgeton Sanitary Landfill Gas Extraction System, Laidlaw Waste Systems, Inc., Arlington Heights, Illinois, 1992**

*Keywords: site history*

In this submittal, Laidlaw Waste Systems Inc., applied for the installation of a Landfill Gas (LFG) flare and reserved the right to pursue the use of the LFG as a useful energy source for this site. None of the information in this report is directly applicable to the West Lake Landfill investigation.

In the application, Laidlaw describes the LFG as generated by the anaerobic decomposition of refuse buried in the landfill and consisting mainly of methane (45-50%), carbon dioxide (45% - 50%), trace amounts of organic compounds, and sulfur bearing compounds. The existing permitted LFG extraction and ventilation system was proposed for upgrade to provide active gas extraction from active and closed portions of the sanitary landfill. Extraction would be achieved via header connection to fourteen (14) existing wells, four (4) new wells, and three (3) new horizontal trenches to dual multi-staged gas blowers. The extracted LFG will be incinerated by a 2,500 standard cubic feet per minute (SCFM)-capacity IT McGill enclosed flare.

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**EPA-TES Trip Report-West Lake Landfill Bridgeton, Missouri  
U.S. EPA Region VII - Technical Enforcement Support, October 1992**

*Keywords: Ford property, site history*

The main purpose of the site visit was to familiarize Ms. Diana Newman (EPA) with the site physiography, topography, and to gain insight on site current conditions. In addition, M&E and the EPA personnel visited Earth City Industrial Park (Ford) property (adjacent to the northern boundary of the landfill) to observe the characteristics of the two areas impacted by radiological contamination.



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**Environmental Investigation And Health Impact Assessment, West Lake Landfill  
Adeshina, F F And Forrest, G R Golder Associates Inc October 1993**

*Keywords risk assessment radon uranium radium thorium source inventory external dose berm*

An Environmental Investigation and Health Impact Assessment was conducted at the Laidlaw Sanitary Landfill Site (Site) located in Bridgeton Missouri. Specific areas at the Site which appear to have been impacted by the low-level radioactive wastes deposited in Areas 1 and 2 of the adjacent West Lake Landfill were identified during this comprehensive environmental media investigation. Based on the analytical data, it was determined that the inhalation pathway does not pose a potential threat to the health of workers. Based on modeling results, it was determined that radon gas concentrations in the ambient air due to landfill gas emissions from flaring would not pose a potential air-quality problem.

Direct-reading working-level Thompson and Nielson monitors were used to evaluate the potential effect to on-site workers from inhalation exposure. The results of the health assessment indicated that the measured concentrations of radon daughter products are almost 10 times below the U.S. EPA regulatory limit of 0.03 working levels (WL) for indoor exposure. Furthermore, the results of modeling to predict the potential effects of radon gas flare emissions to on-site workers and off-site receptors indicated that worst-case, one-hour concentrations could be three orders of magnitude below the U.S. EPA's recommended 4 pCi/L annual average level for homes.

The potential ingestion of leachate- or condensate-contaminated water by on-site workers was found to be of no potential health concern because of maximum detected concentrations that were below EPA proposed maximum contaminant levels. The results of wipe tests in the office building and on heavy equipment at the Site also indicate that potential incidental ingestion of transferable contamination is not a viable exposure route.

After reviewing the source inventory, Golder concluded that most of the types of radionuclides present in the landfill do not emit photons, or only emit low-energy photons that are not highly penetrating. Although, some of the radionuclides which are present (e.g., bismuth-214) emit relatively high energy photons, these emissions could be completely shielded by soil. As a result, it was concluded that a three-meter (10 ft) thick, clean, soil cover would be sufficient to shield against external radiation (e.g., x-ray and gamma ray) emissions.

## EPA FILE SUMMARY - WEST LAKE LANDFILL NPL SITE

### GENERAL BACKGROUND

In early 1966, the Continental Mining and Milling Company, Chicago Illinois, purchased (from the Atomic Energy Commission) ore residues which were stored at the St Louis Airport. The AEC's invitation to bid listed the following residue for purchase: 74,000 tons of Belgium Congo pitchblende raffinate containing about 113 tons of uranium, 32,500 tons of Colorado raffinate containing about 48 tons of uranium, and 8,700 tons of leached barium sulfate containing about 7 tons of uranium.

During 1966, this material was moved from the Airport site to the 9200 Latty Avenue Hazelwood Missouri site. Continental Mining and Milling Company possessed License No. SMA 862 for this program. In January 1967, the Commercial Discount Corporation of Chicago, Illinois, took physical possession of the stockpile. License No. SMC-907 was issued to Commercial Discount Corporation on December 29, 1966, allowing possession of the residues, removal of moisture and shipment of the dried residue to the Cotter Corporation facilities in Canon City, Colorado. In December 1969, the remaining source material was sold to Cotter Corporation under License No. SUB-1022.

In August 1970, Cotter Corporation began drying and shipping the remaining residues from the St Louis site to their mill in Canon City, Colorado. Approximately 400 dry tons of material per day were processed and shipped in this operation. The operation, which was performed for Cotter Corporation by B&K Construction Company, continued until about November 1970. During the August to November period, all of the residues were shipped to Canon City with the exception of approximately 10,000 tons of Colorado raffinate and 8,700 tons of leached barium sulfate, containing about 7 tons of uranium oxide ( $U_3O_8$ ). The 8,700 tons of leached barium sulfate were mixed with about 39,000 tons of soil at the Latty Avenue site.

In April, 1974, Region III representatives of NRC's Office of Inspection and Enforcement visited the Cotter Corporation's Latty Avenue site to check on the progress of the decommissioning activities being performed there. This inspection disclosed that in 1973 Cotter Corporation had disposed of approximately 8,700 tons of leached barium sulfate residues mixed with 39,000 tons of soil at a local landfill.

By letter dated June 2, 1976, the Missouri Department of Natural Resources (MDNR) forwarded to the NRC's Region III office newspaper articles which alleged that only 9,000 tons of waste had been moved from the Latty Avenue site rather than 40,000 tons and that

it was moved to the West Lake Landfill in Bridgeton, and that the waste was covered with only about 3 feet of soil

The West Lake Landfill had been used since 1962 for the disposal of municipal refuse, industrial solid and liquid wastes, and construction demolition debris. Between 1939 and the spring of 1987, limestone was quarried there. Landfill operations filled in some of the excavated pits from the quarry operations. Also on the property is an active industrial complex in which concrete ingredients are measured and combined before mixing ("batching"), and asphalt aggregate is prepared.

The unregulated landfill, in which the radioactive material was placed in 1973, was closed in 1974 by the Missouri Department of Natural Resources (MDNR). Also in 1974, under an MDNR permit, a newer sanitary landfill was opened and now operates in an adjacent area on the West Lake Landfill property. The newer landfill is protected from groundwater contact and a leachate collection system has been installed. Leachate is pumped to a treatment system consisting of a lime precipitation unit followed in series by an aerated lagoon and two unaerated lagoons. The final lagoon effluent is discharged into St. Louis Metropolitan Sewer District sewers.

Numerous investigations have been conducted to delineate the areas and media impacted by the disposition of the residue-soil mixture at the West Lake Landfill. These investigations include reviews of pertinent records, interviews of individuals, and independent sampling measurements and chemical analyses. The file documents summarizing these investigations are described in the remainder of this document.

## SUMMARIES OF FILED DOCUMENTS

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EPA-0055

Office Of Inspection And Enforcement Investigation Report No 76-01  
United States Nuclear Regulatory Commission, August 1976

*Keywords radiological characterization site history cover*

The earliest reports of the waste disposal action appeared in the Post-Dispatch, a St. Louis newspaper. These reports led to an NRC investigation consisting of interviews and visits to the Latty Ave. and West Lake Landfill sites. Environmental samples were taken and beta-gamma surveys were made at the Latty Avenue and West Lake Landfill sites on August 11, 1976. The Latty Avenue site and environs was revisited on October 20, 1976.

for additional environmental samples and alpha, beta-gamma direct surveys. The Latty Avenue environmental samples confirmed the removal of the bulk of materials but showed that some residual contamination remained. The Latty Avenue surveys showed radiation levels exceeding NRC criteria for decontamination of land areas prior to return to unrestricted use. The West Lake Landfill surveys indicated that radioactive material was buried there.

Based on the information collected, NRC investigators concluded that

- About 8,700 tons of leached barium sulfate residues had been mixed with about 39,000 tons of soil at Latty Avenue.
- During the period July 16 to October 9, 1973, over 43,000 tons of waste and soil were removed from the Latty Avenue site.
- The 43,000 tons of waste and soil were dumped at the West Lake Landfill.
- The material dumped at West Lake Landfill was covered by about 3 feet of other [non-contaminated] soil.

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#### **NRC 0158**

#### **Report On Site Visit - West Lake Landfill, St. Louis County, Missouri Radiation Management Corp., 1981**

*Keywords: water analysis, soil analysis, external dose*

A fly-over radiological survey (ARMS flight) performed in 1978 showed external radiation levels as high as 100  $\mu$ R/hr in the area indicated by the site supervisor as that where Latty Avenue materials were disposed. This survey revealed another possible contaminated area in a fill area previously believed to be 'clean'. In September and November of 1980, Radiation Management Corporation (RMC) visited the West Lake Landfill in St. Louis County, Missouri, and performed a detailed radiological survey of the West Lake Landfill under contract to the NRC.

This survey was necessary to determine the extent of radiological contamination. The purpose of these visits was to (1) define the radiological conditions of the West Lake Landfill site, (2) obtain sufficient data to allow RMC to prepare a detailed site radiological survey plan, and (3) perform an engineering evaluation to determine whether remedial actions should and can be taken. Prior to this survey, little was known about the location or activity of radio nuclide bearing soils in the landfill. The RMC survey included

- measurement of external dose rates,
- grab-sample air evaluations, and
- water and surface soil analyses

As a result of the visits, RMC was able to define two extensive areas of contamination. Based in preliminary measurements, RMC concluded that radiation exposure risk to site workers were minimal. Elevated concentrations of uranium and daughters existed in landfill soils but no unusual levels were detected in off-site field soils. RMC did not find any indications that groundwater movement of materials from the site had occurred. Results of the preliminary site visits were used to develop site survey plans for additional investigations.

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EPA-0057 - NUREG/CR 2722

Radiological Survey Of The West Lake Landfill, St Louis County, Missouri,  
Radiation Management Corporation

under contract to Division of Fuel Cycle and Material Safety

Office of the Nuclear Material Safety and Safeguards, U S Nuclear Regulatory  
Commission, May 1982

*Keywords radiological characterization chemical analysis radon vegetation subsurface soil radium  
thorium protactinium risk assessment cover*

The results of a radiological survey of the West Lake Landfill performed by Radiation Management Corp (RMC) during the spring and summer of 1981 was presented in this report. The purpose of this survey was to define the radiological conditions of the West Lake Landfill site to an extent sufficient to allow an engineering evaluation for determination whether remedial actions should and could be undertaken.

Surface gamma surveys, surface beta-gamma surveys, and direct measurement of soils, groundwater, vegetation, and air were performed on-site using two mobile facilities designed by RMC. A small number of samples were returned to the RMC radiological laboratories in Philadelphia for (1) radiological analyses which could not be performed in the field, and (2) quality assurance checks on the field measurements. In addition, a series of nonradiological measurements were performed to identify the possible presence of toxic or hazardous chemicals.

The measurements used to evaluate the site included the following

- external gamma exposure rate 1 meter above the ground surface and beta-gamma count rates 1 cm above the ground surface,
- radionuclide concentrations in surface soils,
- radionuclide concentrations in subsurface deposits
- gross activity and radionuclide concentrations in surface and subsurface water samples
- radon flux emanating from surfaces
- airborne radioactivity,
- gross activity in vegetation, and
- measurement of radon gas emanation and accumulation in a building on-site

The survey results were interpreted to indicate that the West Lake Landfill contained two areas of surface and/or subsurface contamination. External radiation levels are detectable in both areas. The highest reading detected in the most recent survey was 1.6 mR/hr in Area 2, near a utility building that was denoted as the "Shuman Building".

Analyses of soil samples from both areas, as well as in-situ measurements, showed that the contaminants present at West Lake consist of uranium and uranium daughters. Chemical analyses revealed that high concentrations of barium and sulfates were present in the radioactive material. These results were interpreted to confirm reports that the radioactive material was composed of uranium and uranium ore, which were contained in leached barium sulfate residues transferred from the Latty Avenue site in Hazelwood, Missouri.

Analysis of soils also showed an elevated ratio of thorium-230 ( $\text{Th}^{230}$ ) to radium-226 ( $\text{Ra}^{226}$ ). Also, the concentrations of protactinium-231 ( $\text{Pa}^{231}$ ), inferred from radium-223 ( $\text{Ra}^{223}$ ) determinations, were shown to be high. It was inferred that the relatively high concentration of thorium resulted from separation of both uranium and radium from the uranium ores, thus "depleting" the ores of uranium and radium, or "enriching" the residues in thorium. The postulated "enrichment" model was supported by the observed presence of  $\text{Pa}^{231}$  which would be expected to remain in the soil.

The RMC survey results indicated that radioactivity is due to members of the naturally-occurring uranium-238 ( $\text{U}^{238}$ ) and uranium-235 ( $\text{U}^{235}$ ) series. Left in an undisturbed state

radionuclides would be expected to establish secular equilibrium. For a sample of material in secular equilibrium, the activity of each radio nuclide in a given decay series will equal the activity of every other radio nuclide in that series. Because  $Ra^{226}$  was depleted with respect to  $Th^{230}$ ,  $Ra^{226}$  activity will increase over time to a level in excess of those observed at the time of the analysis. As a result,  $Ra^{226}$  activity will increase ninefold over the present level over the next 200 years which must be taken into consideration when developing remedial action plans.

Auger hole measurements were collected using sodium-iodide detectors and intrinsic germanium detector coupled to a multi-channel analyzer. The measurement data showed that nearly all the contamination present was located below the landfill surface. Additional locations near the northwest berm in Area 2 exhibited anomalous radiation and were identified as suspect area where radioactive contamination might be present at the surface or near-surface. The radioactive zones ranged from 2 to 15 feet in thickness, and appeared to form a contiguous layer covering an area of about 14 acres (68,000 sq yd) in Area 2 and about 2 acres (10,000 sq yd) in Area 1. RMC estimated that 150,000 cu yd of radioactive material may have been buried within the two areas. This quantity would correspond to roughly 170,000 tons of soil.

It was noted by RMC that some on-site samples have exhibited gross beta activity above EPA drinking water guidelines (attributable to krypton-40), but that radioactivity in off-site water samples was not observed to exceed applicable guidelines. The absence of significant contamination in the leachate liquid or sludge was cited to suggest that the buried ore residues were (1) probably not soluble, (2) not moving through the landfill and (3) not moving off-site via groundwater.

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EPA-0036

**Report Of Water Sample Analyses**

from Scott Meierotto to Mr William Canney, c/o West Lake Quarry, Hazelwood, MO 63044, 1982

*Keywords groundwater analysis*

This report is a custody and transmittal document for the analyses of groundwater samples from 8 of the 9 monitoring wells at the West Lake Landfill property. The water samples were collected on December 10, 1981. The analyses reported included (1) principal cations/anions, (2) metals and (3) water quality parameters (e.g. turbidity, alkalinity, COD etc). No radio nuclide analyses were performed.

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NRC-0012

**Survey For Berm Erosion West Lake Landfill, St Louis County, Missouri  
Oak Ridge Associated Universities, April 1984**

*Keywords radiological characterization berm Ford property soil analysis radium thorium protactinium cover*

In March, 1984 representatives from Oak Ridge Associated Universities (ORAU) performed a radiological survey along a section of the berm bounding the West Lake Landfill to determine if erosion of the berm was leading to contamination of the adjacent property (designated as the Ford Property ). Information collected included exposure rates radionuclide concentrations in surface soil, and the location of elevated contact radiation levels relative to the surface topography

An initial scan performed with sodium iodide (NaI) scintillation detectors indicated that elevated readings were present along the berm in the far west portion of the landfill This area was selected for further study and no further measurements or sampling were undertaken in other portions of the landfill Radionuclides determined to be present included  $\text{Ra}^{226}$ ,  $\text{Th}^{230}$ ,  $\text{Pa}^{231}$ , and actinium-227 ( $\text{Ac}^{227}$ ) The maximum concentrations of  $\text{Ra}^{226}$  were 699 pCi/g and 662 pCi/g Ratios of  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  ranged from 25.1 to 40.1

The study concluded that (1) erosion was occurring, (2) concentrations of  $\text{Ra}^{226}$  and  $\text{Th}^{230}$  were elevated at the base of the berm, and (3) radiological contamination appears to extend onto the adjacent property ORAU also determined that 1.0-1.5 meters of additional fill had been applied to a portion of the landfill near the office building (designated as the Shuman Building ) The study estimates that the additional fill reduced direct radiation levels at some locations by a factor of 2

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NRC-0204

**Engineering Evaluation of Options for Disposition of Radioactively Contaminated Residues Presently in the West Lake Landfill, St Louis, Missouri  
University of Missouri, Columbia, December 1984**

*Keywords risk assessment berm radium, thorium radon, engineering assessment remedial action cost*

[NOTE The date of this study is uncertain Three copies of the University of Missouri report are in the document record The review copy is described as a draft and dated November 1984 but the pages of the report have a printout date of July 17, 1989 A second copy was transmitted to Oak Ridge Associated Universities (ORAU) in December 1984 but the attached report also has a printout date of July 17, 1989 Handwritten notations on a third version edited by the NRC indicate that the final review was completed after July 1989 Others have observed this inconsistency and suggest that ORAU retyped the report on July



17 1989 as a final version but never changed the date of original authorship The file copy is incomplete and lacks several tables and appendices ]

In March 1983, ORAU, acting as an agent for NRC, contracted with the University of Missouri - Columbia Department of Civil Engineering (UMC) to conduct an environmental impact assessment and engineering evaluation of possible remedial measures at the West Lake Landfill Only the radiological aspect of the landfill was to be considered in the study

Most of the information presented in the report was obtained from existing reports and memoranda with only limited collection of on-site data by UMC personnel in 1983 and ORAU personnel in March 1984 These data confirmed the previous measurements by Radiation Management Corporation (RMC), with the exception that higher levels of surface contamination were discovered in March 1984 on the slope of the berm This data was interpreted as evidence that surface erosion is responsible for uncovering buried radioactive material, as was hypothesized in the earlier RMC report

Present and future doses were calculated using DOE procedures for a hypothetical Maximally Exposed Individual (MEI) The dose to a MEI approximates the maximum possible dose anyone could receive from radioactive debris in the West Lake Landfill The calculated doses are above guidelines for exposure to individual members of the population

Assumptions used in the dose calculations include the following

- Using the RMC data and averaging the auger hole measurements over the two volumes of radioactive material found in Areas 1 and 2 a mean concentration of 90 pCi/g was calculated for  $\text{Ra}^{226}$
- Next, the ratios of  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  must be established since the level of  $\text{Th}^{230}$  will determine the increase of  $\text{Ra}^{226}$  with time The ratio of  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  ranged from 5:1 to 150:1, with most of the data in the 30:1 to 50:1 range
- The total mass of radioactive material in the landfill was stated in the RMC report as  $6 \times 10^{11}$  grams UMC verified this estimate by visually integrating the volume of radioactive material from the graphs in the RMC report and multiplying by an average soil density, resulting in  $1.5 \times 10^{11}$  grams UMC determined that the total activity of radiological materials could range between 1,600 Ci and 7,000 Ci
- Knowing the total  $\text{Ra}^{226}$  activity in the site, UMC estimated that the release of radon-222 ( $\text{Rn}^{222}$ ) gas from the surface of the landfill was 25 Ci/sec

- UMC noted that the radon gas flux level will not be constant over time due to the depletion of  $\text{Ra}^{226}$  relative to  $\text{Th}^{230}$ . The  $\text{Ra}^{226}$  activity (and thus the  $\text{Rn}^{222}$  gas flux) will increase by a factor of five over the next 100 years, by a factor of nine 200 years from now and by a factor of thirty-five 1,000 years from now. All radionuclides in the decay chain below  $\text{Ra}^{226}$  will also be increased by this amount.

Based upon this characterization of the material present and using established guidelines some type of remedial action is needed to protect the public from unrestricted use of the site. Although many radionuclides in the radioactive material are at or near threshold for remedial action,  $\text{Th}^{230}$  and  $\text{Ra}^{226}$  levels are greater than specified by these guidelines. This also creates the situation where the  $\text{Ra}^{226}$  activity will increase with time requiring action to preclude possible increased exposure in the future. Calculations do indicate, however that simple remedial action at the site will result in negligible exposure to the general public and only moderate exposure of the worst exposed individual who would routinely work at the site.

The following remedial action options were evaluated in this study for feasibility of implementation, reduction in radiation exposures, environmental impacts, and cost:

Option A - No remedial action

Option B - Stabilization on-site with restricted land use

Option C - Extending the landfill off site

Option D - Removing radioactive soil and relocating it at Barnwell, S C

Option E - Extensive stabilization on-site with land-use restrictions

Option F - Extensive stabilization on-site with land-use restrictions and construction of slurry walls to control groundwater motion

Option B, stabilization on-site with land-use restriction, was chosen as the best alternative. This alternative (B) would involve covering the contaminated soil with five feet of clean fill excavated from loess deposits near the landfill. This soil layer would reduce surface exposure, radon gas emanation, and infiltration water available to leach radioactive and nonradioactive wastes from within the landfill. The berm along the northwest side of the landfill would be rebuilt to halt the erosion of radioactive soil. After this stabilization has been completed, the surface of the contaminated areas will be available for placement of another layer of demolition fill. The alternative options (C, D, E, and F) were not recommended because of relatively high costs and/or inappropriate use of space in a licensed waste disposal.

Land-use restrictions would be necessary to ensure that the site, after closure, is put to some use such that excavation on-site will be unlikely and future construction on the site is discouraged. Establishment of an appropriate land-use pattern at the time of closure rather than temporarily fencing off the area from all use was judged to be the most effective method for preventing inappropriate activity on the site far into the future. A park, golf course, or parking lot(s) would all be examples of acceptable future uses for the site. Costs of stabilization work for Option B were estimated to be \$367,000.

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**Hydrogeologic Investigation West Lake Landfill, Primary Phase Report  
Burns & McDonnell, Kansas City Missouri, October 1986**

*Keywords groundwater flow groundwater quality*

This document is the first comprehensive study of the hydrogeology of the vadose zone and unconsolidated alluvium at the site. The study does not address bedrock hydrodynamics nor water quality. The results of sampling and analyses of the groundwater from pre-existing and newly installed monitoring wells are presented. A total of 18 wells were sampled during two sampling rounds: 1) the winter of 1985 and 2) the summer of 1986. Chemical analyses included major chemistry and hazardous constituents (EPA Methods 624 and 625). Radiochemical analyses were not performed but gross alpha and gross beta determinations were reported.

The lithology and stratigraphy of the unconsolidated sediments were not fully described in this report. Moreover, the vertical and horizontal extent of contamination were not adequately addressed. The report concluded that there was only minor evidence of leaching of radioactive contaminants from the wastes to the groundwater. The presence of other pollutants in the groundwater was reported to be of minor significance.

The authors note the presence of a groundwater mound located on the southern part of the site. They ascribe the mounding effect to (1) water being pumped from the quarry and discharged at the ground surface up-gradient of the mound, (2) surface infiltration from the drainage ditches along Old St. Charles Rock Road, and (3) possible leakage from surface water holding ponds immediately west of the existing quarry. Groundwater gradients are described as extremely low. The authors estimate that groundwater flow rates in the upper and lower zones of the unconsolidated aquifer at 500 gpd and 400,000 gpd respectively. Principal findings from this report are included below:

- The alluvium of the Missouri River forms the major aquifer in the vicinity of the site. The underlying bedrock which forms the valley floor is buried beneath the alluvium.

- Alluvial deposits of the Missouri River are in hydraulic communication with the river, thus the river has a major influence on water levels in the alluvium. Although the rise and fall of the aquifer is less than that of the correlative change in river stage, the change in groundwater elevation is relatively uniform throughout the entire extent of the aquifer in the site vicinity.
- The predominant direction of groundwater flow in the aquifer in the region near the site is northwestward toward the Missouri River. There are broad fluctuations in this flow direction throughout the year and the predominant flow direction ranges from slightly south of due west to northwest. During short periods of the year (primarily in the spring and for short periods in winter), when the river stage is rising rapidly, the predominant groundwater flow direction in the aquifer may be temporarily reversed in the localized vicinity of the river.
- Other localized effects of only minor significance, may affect groundwater flow directions in the aquifer. The only local feature of note is a perennial groundwater mound.
- Throughout most of its extent, the aquifer is generally unconfined. Relatively low-permeability, discontinuous clayey and silty zones within the alluvium may cause semiconfined and perched water conditions in localized areas.
- Gradients in hydraulic head in the lower aquifer are at times, extremely low. Thus, minor fluctuations in head (in the range of 1/10-foot in any one well) may be sufficient to cause changes in flow direction. But because the gradients are very low at such times, groundwater flow rates are negligible.
- At times, there may be two to three feet of differential in hydraulic head across the site. The pattern in hydraulic head distribution in the deep aquifer at such times is seen to reflect approximately the same pattern as the head distribution in the shallow aquifer. Thus, the surface water features which recharge the shallow part of the aquifer and cause groundwater recharge in the southeastern part of the site also recharge the deeper part of the aquifer by vertical infiltration from above. During such times, groundwater flow in the deep portion of the aquifer is predominantly towards the west and northwest. During all times of measurement, the hydraulic gradients in the deeper part of the aquifer were substantially less than that in the shallow part of the aquifer.
- The groundwater flow rates in the upper and lower zones of the aquifer are estimated to be 500 gallons per day and 400 000 gallons per day, respectively.

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Hydrogeological Investigation of the West Lake Landfill  
Dames & Moore , October 1986

(NOTE report mentioned in EPA-TES reports but no copies exist in the file record)

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NUREG-1308 / NRC-0222

Radioactive Material in the West Lake Landfill, Summary Report Rev 1  
Division of Industrial and Medical Nuclear Safety, Office of Nuclear Material Safety  
and Safeguards  
U S Nuclear Regulatory Commission, 1988

*Keywords site history radiological characterization risk assessment remedial action*

The circumstances which led to the disposal of radioactive materials at the West Lake Landfill is described in this Nuclear Regulatory Agency (NRC) summary report. Also described, are the major environmental aspects of the site as they relate to potential disposition of the materials (e.g., areal extent of contaminated ground, geology, hydrology, demographics, etc.). Other sections of the report are devoted to a review of the surveys and analyses that have been conducted and to estimations of the radioactive inventory still present at the site.

The conclusions of the report explain that measures must be taken to establish adequate permanent control of the radioactive waste and to mitigate the potential long-term adverse impacts from its existing temporary storage conditions. Furthermore, the information collected to date was found to be inadequate for a technological determination of several important issues, i.e., whether mixed wastes are involved, whether on-site disposal is practical technologically, and what alternative methods might be acceptable if on-site disposal is found to be impractical.

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**Site Characterization and Remedial Action Concepts for the West Lake Landfill**  
**Office of Nuclear Material Safety and Safeguards Nuclear Regulatory Agency, July 1989**

*Keywords site history radiological characterization risk assessment remedial action*

This report is based on NRC-0204 Engineering Evaluation of Options for Disposition of Radioactively Contaminated Residues Presently in the West Lake Landfill St Louis Missouri and NUREG-1308 / NRC 0222 Radioactive Material in the West Lake Landfill Summary Report Most of the information dates from 1983-1984 when the University of Missouri first compiled their findings However, additional data, such as more recent water sampling results, were added Also described, are existing site conditions including minor changes in details of topography and roads etc caused by continued use of the site as a sanitary landfill

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**Evaluation of the West Lake Landfill Site Hazardous Ranking System (HRS) Scoring Package**

**Foth & Van Dyke, December, 1989**

*Keywords site history risk assessment*

The results of Foth & Van Dyke's investigation regarding the hazardous ranking system (HRS) scoring package and background (support) information for the West Lake Landfill are documented in this letter In addition, an evaluation was made based upon currently available information for the site to ascertain if pollutant or contaminant releases may present imminent and substantial danger to public health and welfare

An evaluation of the impact of the site on the public health and welfare was performed by a Foth & Van Dyke toxicologist An insufficient amount of data was determined to be available to conduct a formal risk assessment Recommendations contained in the report include the following actions

- measure radioactivity of groundwater used at off-site locations,
- determine groundwater usage patterns for the immediate vicinity,
- conduct air sampling and modeling, to determine if this exposure pathway presents a health risk to persons off-site, e g , Spanush Lake Village, Ralston-Purina employees, etc ,

- determine if the radon flux will increase with time as the radioactive decay produces higher levels of radon,
- assuming migration of a contaminated groundwater plume to the Missouri River determine a future radon flux in the area west of the landfill since dwellings in this area may be subject to radon gas contamination,
- conduct an investigation to determine if radon gas is a problem (health hazard) in buildings adjacent to the landfill,
- determine off-site soil contamination e g , farmers fields, neighborhoods etc , and
- collect area surface water and sediment samples for radiological analyses

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**Dames & Moore, Phase II Investigation Report, Ford Property  
U S Real Estate Division, Ford Financial Services, Earth City, Missouri, 1990**

*Keywords Ford property radiological characterization soil analysis groundwater analysis chemical analysis radiochemical analysis soil analysis*

In April, 1990, the Ford Financial Services Group, authorized Dames & Moore (D&M) to proceed with a Phase II Site Investigation to further document conditions at the property adjacent to the West Lake Landfill pursuant to a real estate transaction. The investigation was confined to areas along the western and northwestern perimeter of the landfill and excluded the area around the two "hot spots" located during an earlier Phase I investigation in the interior of the landfill.

The investigation included a walkover gamma survey (designated as "overland survey") at and above the ground surface within two grids. The gamma survey included areas to the north and west of the landfill. A surface soil survey, using a direct reading meter, was conducted to characterize shallow (less than 12 inch depth) soils from property locations adjacent to the landfill where contamination was suspected based on the Phase I results. Four sediment/soil samples were collected from four locations where chemical or radiological contamination might be expected to have migrated from the landfill via surface water. A list of activities conducted during the Phase II investigation included

- surface radiological surveys,
- subsurface radiological and chemical surveys,

- surface sediment/soil sampling,
- monitoring well installation,
- groundwater sampling, and
- chemical and radiological laboratory analyses

The only noteworthy item in the report concerned the discussion of findings of groundwater analyses. Groundwater samples were analyzed both as taken and after filtration with a 45-micron filter. For samples from four wells, the filtered samples were reported as showing radioactivity below the U.S. EPA drinking water standard of 15 pCi/l for gross alpha, 50 pCi/l for gross beta, and 5 pCi/l for  $Ra^{226}$  plus  $Ra^{228}$ . For samples of unfiltered water from the same wells, the gross alpha values were elevated to 17.2 to 202 pCi/l. These elevated values were considered "qualified" by the authors, because the sum of the individual nuclides analyzed did not show a corresponding total of alpha activity. The general findings of this Phase II report were that there was no substantial evidence that radioactive material in the West Lake Landfill has migrated to the northwest and west and onto the Ford property. This conclusion was generally well supported by the data reported. Specific findings for each of the activities conducted are summarized in the following subsections.

## SURFACE RADIOLOGICAL SURVEYS

Gamma radiation surveys were conducted on surface soils in areas north and west of the West Lake Landfill. These areas were investigated because they receive a large amount of surface run-off from the landfill. The surface soil survey was conducted using a direct-reading meter. The surveys indicated that there was no significant surface radiological contamination present.

## SUBSURFACE RADIOLOGICAL AND CHEMICAL SURVEYS

Subsurface soil conditions were surveyed radiologically from the surface to groundwater in several locations to the north and west of the landfill. Gamma radiation was measured in soil borings using a Geiger-Mueller (GM) survey meter. A photoionization detector was used to detect organic chemicals. Neither radiological nor chemical contamination was reportedly indicated by the observed instrument readings.

## SURFACE SEDIMENT/SOIL SAMPLING

A total of twenty-six surface soil samples were collected from 0 to 12 inches in depth below the ground surface from property locations adjacent to the landfill and submitted for



chemical and radiological analysis as either a whole sample or as a composite. Soil samples were collected from (1) locations where contamination was suspected from the Phase I effort, (2) locations where dredge soils from the ditch along Old St. Charles Rock Road, and (3) from unbiased locations along the perimeter of the landfill. Biased sediment/soil sample locations were established where topographic features would favor chemical or radiological contaminant migration from the landfill via surface water.

#### MONITORING WELL INSTALLATION & GROUNDWATER SAMPLING

Groundwater was sampled from newly installed monitoring wells constructed in the same soil borings that were mentioned previously.

#### CHEMICAL AND RADIOLOGICAL LABORATORY ANALYSES

Of all the soil samples collected from adjacent properties, radiological contamination was detected only in the samples collected from the two locations where radiological contamination had been indicated in the Phase I investigation. Other conclusions related to the presence of nonradiological contamination are compiled below.

- Very low levels (parts per billion) of organic contamination were reported for two soil sample composites prepared from sediment/soil collected on adjacent property locations. The reported values were below the analytical limit of detection and were not considered significant.
- Low level (part per billion) concentrations of some organic chemicals were detected in several of the groundwater samples. Several of these, however, were believed to be attributable to background contamination from the laboratory and D&M scientists did not believe the concentrations observed represented a significant environmental concern.
- Two semi-volatile BNAs [chrysene and bis(2-Ethylhexyl)-phthalate] were detected in very low levels (1 to 27 ppb) in four (4) of the groundwater samples.
- Other chemical contaminants tested for in the groundwater (i.e., metals, cyanide) were not present in sufficient concentration to represent a significant environmental concern.
- Gross alpha was the only radiological parameter that appeared to be somewhat elevated in some of the groundwater samples. The sum of the individual components that typically comprise this parameter failed to confirm the gross alpha totals.

Based on these results, the authors of the Phase II report compiled the following conclusions

- Only the samples collected from the two locations where radiological contamination had been indicated from the Phase I investigation exhibited radiological contamination in laboratory analyses and gamma radiation survey
- Radiological contamination present within the landfill did not appear to have influenced the surface gamma radiation readings over the 23 acres surveyed
- There did not appear to be significant groundwater contamination
- The results provided from this investigation were interpreted as evidence that the radioactive material resident in the West Lake Landfill has not migrated to Earth City (Ford) property

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Dames & Moore, Phase III Radiological Site Assessment - Earth City Industrial Park  
Prepared for U S Real Estate Division, Ford Financial Services, Earth City, Missouri,  
June 1991

*Keywords Ford property radiological characterization soil analysis groundwater analysis radium  
thorium uranium remedial action cost*

In April, 1991, a Phase III radiological investigation was conducted by Dames and Moore (D&M) at the Earth City property. The investigation was conducted as a follow-up to the Phase II investigation for the purpose of further characterizing the extent of radiological contamination that was detected in two localized areas during the Phase II investigation. The investigation involved an overland gamma survey, a downhole gamma survey, soil sampling and analysis, and groundwater sampling and analysis.

This Radiological Site Assessment reported that the area and depth of contamination have been established on the two small contaminated areas on adjacent property, which were mentioned in the Phase II report discussed above. The following information regarding these two areas were documented in this report:

- The "northern biased" (D&M designation) location encompasses an area of approximately 4,300 square feet and the depth of contamination was approximately one foot. The predominant nuclides that are present above background levels in this area are  $\text{Ra}^{226}$  and  $\text{U}^{238}$ .  $\text{Ra}^{226}$  was detected in a range of 2.9 to 690 pCi/g and  $\text{U}^{238}$  was detected at one location at a concentration of 5.9 pCi/g.

- The southern biased (D&M designation) location is in a localized area adjacent to the West Lake property fence line.  $\text{Ra}^{226}$  was detected at a range of activities from 2.3 to 43 pCi/g and  $\text{U}^{238}$  was detected at concentrations from 6.7 to 9.2 pCi/g. The contaminated area was determined to be approximately 90 square feet and the depth was approximately 3 to 3.5 feet. Analysis of the groundwater samples indicated no evidence of elevated activities of target nuclides  $\text{Ra}^{226}$ ,  $\text{Th}^{230}$ , and  $\text{U}^{238}$  which are characteristic of radioactive material found in the West Lake Landfill.

Remediation costs were estimated at \$200,000 for excavation, transportation, and disposal of approximately 4,600 cubic feet of contaminated soil. The report recommended additional actions to minimize contamination spread onto the property from the adjacent West Lake Landfill.

The D&M soil sample data consistently shows that the ratios of  $\text{Ra}^{226}$  to  $\text{U}^{238}$  and  $\text{Th}^{230}$  to  $\text{Ra}^{226}$  are enriched. The report notes the strong correlation between the Ford property sample data and the soil sample data presented in the NUREG-1308 report from the St. Louis Airport Site. As a result, it was concluded that the radiological contamination on the Ford property could only have come from materials placed in the West Lake Landfill which were ultimately generated at the St. Louis Airport Site.

D&M does not discuss the inconsistency between  $\text{U}^{238}$  results from two different analysis methods applied to the same groundwater samples. A single paragraph in the Executive Summary states that the analytical results "confirm that no migration of radioactive material into the shallow groundwater has occurred under the Ford property." It goes on to state flatly that the analysis indicated no evidence of elevated  $\text{U}^{238}$ , then recommends an annual analysis program that conspicuously omits the "gamma scan" analysis.

An apparent contradiction in contaminant distribution exists between the Oak Ridge Associated Universities (ORAU) 1984 survey of the north face of the landfill and the Phase III report prepared by D&M. The gamma survey data contained in the Phase III report does not indicate a contaminated area along the boundary at this latitude. The evidence presented does not preclude the possibility that  $\text{Th}^{230}$  contamination may have been spread onto the Ford property field in locations where the gamma readings are below 10 microR/hr.

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## EPA-TES Trip Report

West Lake Landfill, Bridgeton, Missouri, Remedial Investigation/Feasibility Study

U S EPA Region VI, Technical Enforcement Support

Performed By Metcalf & Eddy, Inc , November 1991

*Keywords Ford property berm*

The TES X Contractor, Metcalf & Eddy (M&E), was requested by the U S EPA Region VII to conduct a site visit at West Lake Landfill (West Lake) in Bridgeton, Missouri. West Lake is currently owned and operated by Laidlaw Waste Systems Inc (Laidlaw). The site visit was conducted so that M&E personnel could become familiar with the site physiography, topography, geology, hydrology and current conditions at West Lake. In addition, M&E visited the Earth City Industrial Park (Ford) property (adjacent to the northern boundary of the landfill) to locate and observe the characteristics of the two areas impacted by radiological contamination.

- The TES personnel submitted several findings and recommendations for additional work at West Lake Landfill. These observations are summarized below.
- Historic bedrock quarry activities should be evaluated to gain additional information that will help to evaluate bedrock characteristics, groundwater characteristics and the possible locations of past waste disposal activities.
- The heterogeneous topography of the old portion of the landfill may be the result of uncontrolled waste disposal activities. Aerial photographs also suggest non-systematic shifting of waste disposal areas. The radiological data should be scrutinized to evaluate whether an accurate depiction of the vertical extent of contamination has been made.
- The hydraulic properties of bedrock must be further investigated to characterize hydraulic gradients in the bedrock formation.
- The thickness and elevation of the radiologically contaminated fill material in relation to the elevation of the flood plain (Earth City Industrial Park property) and lack of identified groundwater contamination suggests that through flow probably is not the cause of the contamination at Earth City.
- Berm areas were reworked by Laidlaw bulldozer operators prior to the site visit. A Laidlaw representative stated that these areas were cleared to allow mobilization of utility trucks and drill rigs.

- The location and limited areal extent of contamination on the Earth City Industrial Park property suggest that mass movement of entrained contaminants in berm material and surface water flow are the dominant contaminant migration pathway. It is suggested that berm material be evaluated to determine composition and hydraulic characteristics of the berm.

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## West Lake Landfill Berm Assessment Metcalf & Eddy, 1992

*Keywords: berm, Ford property, remedial actions*

Metcalf & Eddy (M&E) identified the minimum data requirements necessary to perform a preliminary evaluation of the berm at the north end of the West Lake Landfill site and prepared a scope of work for an interim measures study to separate the berm and the adjacent Earth City (Ford) property. Based on the evaluation of previous investigation survey results, M&E identified the following tasks for future implementation:

- Evaluate potential interim measure action alternatives to include surface water diversion and collection systems, and subsurface barriers alternative evaluation.
- Design and install a physical barrier between the West Lake Landfill and the Earth City property to prevent transport (by mass movement or surface water) of radiologically contaminated soils on to the Earth City property.
- Install a representative number of soil borings in the berm to characterize berm soils and further identify areas of contamination. Soil samples should be analyzed for radioactivity, selected radionuclides, and priority pollutants. Non-vertical (angled) borings using lightweight or portable drilling equipment may be necessary to perform this task.
- Groundwater or leachate encountered during boring advancement should be sampled and analyzed for radionuclides and for volatile and semivolatile organic compounds, total petroleum hydrocarbons, pesticides, PCBs, metals, and cyanides.
- The hydraulic, geotechnical, and chemical properties of berm soils must be determined to ascertain if this structure acts to contain contaminants. The description of physical properties of the soils must detail the following: soil type including grain size analysis, specific gravity, moisture content, Atterberg limits, permeability, and biological activity. The description of the soil chemistry should include solubility, ion speciation, adsorption coefficients, leachability, mineral

partition coefficients and chemical and sorptive properties. In addition, the soils should be analyzed for radioactivity, selected radionuclides, and priority pollutants to further define the extent of contamination.

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**Major Modification Submittal - Bridgeton Sanitary Landfill Gas Extraction System  
Laidlaw Waste Systems, Inc., Arlington Heights, Illinois, 1992**

*Keywords: site history*

In this submittal, Laidlaw Waste Systems Inc., applied for the installation of a Landfill Gas (LFG) flare, and reserved the right to pursue the use of the LFG as a useful energy source for this site. None of the information in this report is directly applicable to the West Lake Landfill investigation.

In the application, Laidlaw describes the LFG as generated by the anaerobic decomposition of refuse buried in the landfill and consisting mainly of methane (45-50%), carbon dioxide (45% - 50%), trace amounts of organic compounds, and sulfur bearing compounds. The existing permitted LFG extraction and ventilation system was proposed for upgrade to provide active gas extraction from active and closed portions of the sanitary landfill. Extraction would be achieved via header connection to fourteen (14) existing wells, four (4) new wells, and three (3) new horizontal trenches to dual multi-staged gas blowers. The extracted LFG will be incinerated by a 2,500 standard cubic feet per minute (SCFM)-capacity, IT McGill enclosed flare.

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**EPA-TES Trip Report-West Lake Landfill Bridgeton, Missouri  
U S EPA Region VII - Technical Enforcement Support, October 1992**

*Keywords: Ford property, site history*

The main purpose of the site visit was to familiarize Ms. Diana Newman (EPA) with the site physiography, topography, and to gain insight on site current conditions. In addition, M&E and the EPA personnel visited Earth City Industrial Park (Ford) property (adjacent to the northern boundary of the landfill) to observe the characteristics of the two areas impacted by radiological contamination.

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Environmental Investigation And Health Impact Assessment, West Lake Landfill  
Adeshina, F F And Forrest, G R Golder Associates Inc October 1993

*Keywords risk assessment radon uranium radium thorium source inventory external dose berm*

An Environmental Investigation and Health Impact Assessment was conducted at the Laidlaw Sanitary Landfill Site (Site) located in Bridgeton Missouri. Specific areas at the Site which appear to have been impacted by the low-level radioactive wastes deposited in Areas 1 and 2 of the adjacent West Lake Landfill were identified during this comprehensive environmental media investigation. Based on the analytical data, it was determined that the inhalation pathway does not pose a potential threat to the health of workers. Based on modeling results, it was determined that radon gas concentrations in the ambient air due to landfill gas emissions from flaring would not pose a potential air-quality problem.

Direct-reading working-level Thompson and Nielson monitors were used to evaluate the potential effect to on-site workers from inhalation exposure. The results of the health assessment indicated that the measured concentrations of radon daughter products are almost 10 times below the U.S. EPA regulatory limit of 0.03 working levels (WL) for indoor exposure. Furthermore, the results of modeling to predict the potential effects of radon gas flare emissions to on-site workers and off-site receptors indicated that worst-case, one-hour concentrations could be three orders of magnitude below the U.S. EPA's recommended 4 pCi/L annual average level for homes.

The potential ingestion of leachate- or condensate-contaminated water by on-site workers was found to be of no potential health concern because of maximum detected concentrations that were below EPA proposed maximum contaminant levels. The results of wipe tests in the office building and on heavy equipment at the Site also indicate that potential incidental ingestion of transferable contamination is not a viable exposure route.

After reviewing the source inventory, Golder concluded that most of the types of radionuclides present in the landfill do not emit photons, or only emit low-energy photons that are not highly penetrating. Although, some of the radionuclides which are present (e.g., bismuth-214) emit relatively high energy photons, these emissions could be completely shielded by soil. As a result, it was concluded that a three-meter (10 ft) thick, clean soil cover would be sufficient to shield against external radiation (e.g., x-ray and gamma ray) emissions.